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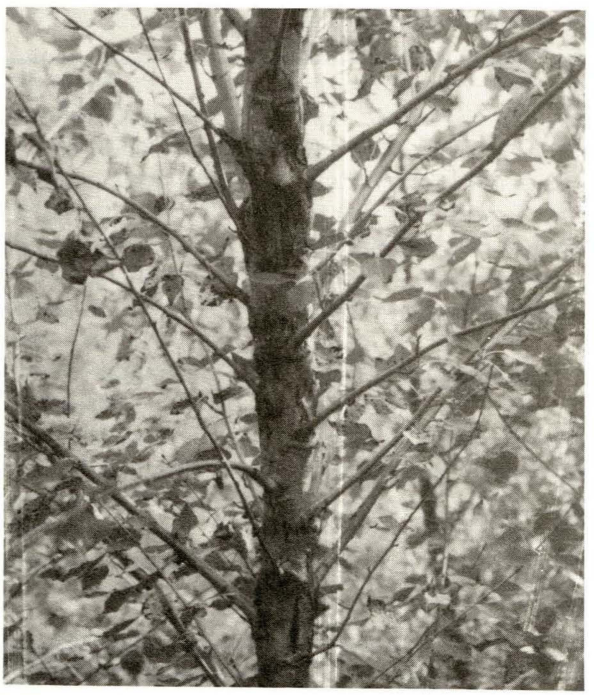

Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.

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Impact and Control of *Septoria Musiva* on Hybrid Poplars

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Septoria musiva Peck and its ascogenous state, *Mycosphaerella populorum* Thompson, have extensively damaged hybrid *Populus* planted in the north central United States. Many of the clones recently planted for fiber and energy production in intensively managed plantations are highly susceptible to *S. musiva*, resulting in premature defoliation and multiple branch and stem cankers (Ostry and McNabb 1985). Biomass yields from highly susceptible clones are limited, and coppice reproduction is reduced by these diseases (McNabb *et al.* 1982, Moore *et al.* 1982).

From 1975 to 1980, nearly 1,200 ha of hybrid poplars were planted in central lower Michigan for fiber packaging material. The goal was to obtain 25-cm-d.b.h. trees on a 15-year rotation. Many of these plantations were established before *Septoria*-resistant clones were identified. By the early 1980's most of the trees of susceptible clones were affected by the foliar and canker diseases caused by *S. musiva*. A study was undertaken to: (1) assess the impact of *Septoria* on the affected plantations and to determine if the trees could be carried to full rotation, (2) determine if disease severity of susceptible clones could be minimized by planting mixtures of clones with differing resistance to *S. musiva*, and (3) determine if pruning and sanitation could reduce disease severity within plantations.

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MATERIALS AND METHODS

Disease Progression and Impact

This study was conducted in a mixed-hybrid *Populus* plantation in Mason County, Michigan. The plantation was established in the spring of 1979 with unrooted hardwood cuttings of a random mixture of clones spaced 2.4 m apart within rows and 3.0 m between rows. In March 1984 five plots were randomly established within this plantation. Each plot consisted of three rows of 10 trees each. Because some of the trees had multiple stems, 180 stems were premanently marked within the plantation. Tree height and diameter were measured at the time of plot establishment and again in 1985. Each fall of 1984 to 1986 the incidence and severity of Septoria canker were recorded by using the categories: healthy, no cankers; branch cankers only; 1-2 stem cankers; 3+ stem cankers; top broken at canker; and dead, killed by *Septoria*.

Clone Deployment

During the spring of 1980, a 2.9-ha research plot was established within each of three plantations of hybrid poplars, two in Manistee County and one in Mason County, Michigan. The three plantations ranged in size from 8 to 28 ha. Each plot was delimited from the remainder of the plantation and consisted of three rectangular blocks planted with cuttings of 32 hybrid poplar clones (table 1). To help identify each clone, the ends of the cuttings were sprayed with latex paint in various color combinations. Approximately 128 unrooted hardwood cuttings of each clone were mixed together and randomly planted in each block, spaced 2.4 m apart within rows and 3.0 m between rows (approximately 1,359 cuttings/ha). After planting, the identity of all cuttings was mapped for future reference.

Table 1.—*Disease susceptibility of* Populus *clones planted in random mixtures in Michigan, 1980-1986*[1]

Clone	Parentage	Disease susceptibility[1]
NE 253	*P. deltoides* var. *angulata* X *P. trichocarpa*	S
NE 235	*P. deltoides* X *P. nigra* Incrassata	S
NE 386	*P. candicans* X (*P.* X *berolinensis*)	S
NE 387		S
NE 388	*P. maximowiczii* X *P. trichocarpa*	S
NE 375	*P. deltoides* var. *angulata* X *P. nigra* var. *plantierensis*	-
NE 373	*P. deltoides* var. *angulata* X *P. trichocarpa*	S,M
NE 252		S
NE 300	*P. nigra* var. *betulifolia* X *P. trichocarpa*	S
NE 17	*P. nigra* var. *charkowiensis* X *P. nigra* var. *caudina*	S
NE 19		-
NE 20		S
NE 205		S,M
NE 206	*P. deltoides* X *P. trichocarpa*	S,R
NE 359		S
NE 207		S,M
NE 351	*P. deltoides* X *P. nigra* var. *caudina*	S
NE 353		-
NE 366		S
NE 367		M
NE 264	*P. deltoides* var. *angulata* X *P. nigra* Volga	M
NE 238	*P. deltoides* X *P. nigra* Volga	-
NE 278	*P. nigra* X (*P.* X *euramericana* Eugenii)	-
NE 51	*P. maximowiczii* X *P. nigra* var. *plantierensis*	-
Wisc 5	*P.* X *euramericana* Wisconsin #5	-
I45-51	*P.* X *euramericana* I45-51	M
Raverdeau	*P.* X *euramericana* Robusta Raverdeau	-
DN 34	*P.* X *euramericana* Eugenii	-
DN 30	*P.* X *euramericana* Canada Blanc	-
DN 21	*P.* X *euramericana* Jacometti	-
DN 28	*P.* X *euramericana* Ostia	-
DN 17	*P.* X *euramericana* Robusta	-

[1] S = *Septoria* canker, M = *Marssonina* leaf blight, and R = *Melampsora* leaf rust. Clones were either prematurely defoliated or subject to stem cankers in all three plantations to such a degree that these clones should not be planted where these pathogens are known to be a problem. Clones with no rating were either disease-free or only slightly affected during the study period in Michigan. However, several of these clones are known to be susceptible to one or more diseases in other areas of the north central United States.

During each growing season from 1980 to 1986, the incidence and severity of insects and diseases affecting trees in the plots were assessed monthly by examining every tree in one of the blocks in each plantation. Insects and diseases affecting tree foliage were rated on the scale: Slight = 1 to 33 percent of the foliage affected, Moderate = 34 to 66 percent, Severe = 67 to 100 percent. Insects and diseases affecting tree branches and stems were rated as follows: Slight = affecting a few branches only, Moderate = affecting many branches and/or stems, Severe = affecting stems so that tree breakage was occurring. Additionally, tree survival was recorded in 1983.

Pruning/Sanitation

In May 1982, a pruning/sanitation study was established in a 3-year-old mixed-hybrid poplar plantation in Mason County, Michigan. Six plots of 100 trees each were randomly located, and all chosen trees were marked with numbered metal tags. Tree height, diameter, and incidence of Septoria leafspot and canker were recorded. Trees on two of the plots were pruned to remove the lower one-third of the crown. Septoria cankers found after pruning were not removed. On another two plots, all trees with stem cankers were removed, and the remaining trees were pruned as on the previous plots. The final two plots served as controls and received no treatment. Spore traps (Ostry and Nicholls 1982) were placed in each plot and monitored weekly to determine the presence of inoculum within the plantation. Canker incidence was recorded each year from 1982 to 1984. Canker incidence, tree survival, and diameters were recorded in the fall of 1986. The incidence of poplar-willow-borer *Cryptorhynchus lapathi* (L.) attacks was recorded throughout the study period.

RESULTS AND DISCUSSION

Disease Progression and Impact

Five years after planting, 86 percent of the trees had Septoria cankers (table 2). By August of 1984, five months after the plots were established, 33 percent of the trees had broken tops; and by September of 1986, seven years after planting, 69 percent of the trees had broken tops. Although few trees died, many of the trees with broken tops lost as much as one-third of their total height growth by the end of the study. The mean tree diameter and height in 1984 was 7.7 cm and 7.4 m respectively. The mean tree diameter in 1986 was 10.0 cm, and most infected trees with broken tops had not formed new leaders.

Table 2.—*Incidence of* Septoria*-infected trees and tree mortality in a Michigan plantation of hybrid poplars, 1984-1986*[1]

Tree condition	Percentage of trees affected on:[2] 3-84	8-84	9-85	9-86
Healthy, no cankers	14	9	8	4
Branch cankers only	4	4	3	2
1-2 bole cankers	16	13	12	7
3+ bole cankers	57	40	32	17
Top broken at canker	9	33	44	69
Dead, killed by *Septoria*	0	1	1	1

[1] Planted 1979.
[2] N = 180.

The incidence and severity of *Septoria* differed among clones. Because the plantation was just reaching the midpoint in its planned 15-year rotation at the end of this study, it was doubtful that any of the highly susceptible trees will survive to the projected harvest age. Only scattered groups of resistant trees will remain, making this plantation uneconomical to manage.

Clone Deployment

Survival of individual clones after 3 years ranged from 38 to 93 percent, averaging 69, 71, and 66 percent on the three sites. The incidence and severity of disease and insect attacks on specific clones were similar at all three sites and were similar to previous findings (Moore et al. 1982, Ostry and McNabb 1985). Three major pathogens and one insect pest seriously affected many of the clones. *Septoria musiva* had by far the greatest impact on trees, causing premature defoliation and stem cankers that resulted in dead and broken tops (figs. 1 and 2). *Marssonina brunnea* (Ell. & Ev.) Magn. and *Melampsora medusae* Thum. also caused premature defoliation of several highly susceptible clones. The major damaging insect pest was the poplar-and-willow borer. This borer was often present on trees also affected by Septoria canker, but no clonal preferences were discernible because of the low incidence of borer attacks.

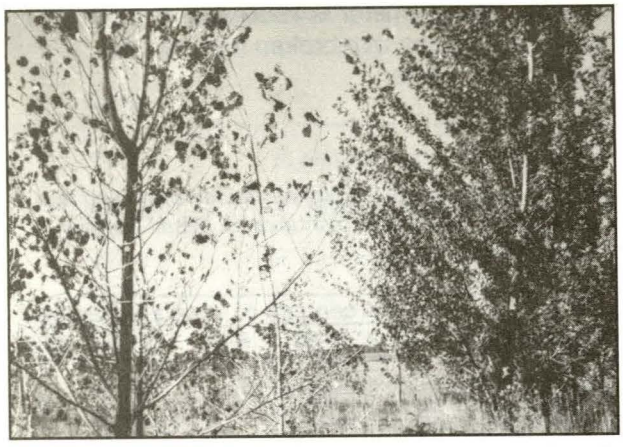

Figure 1.–*Partially defoliated* Populus *clone susceptible to* Septoria musiva *(left) compared with resistant clone.*

Within each planting, all trees of the same clone were similarly affected by the same pathogen. Often a clone could be identified on the basis of the severity of the particular disease to which it was susceptible. The presence of resistant trees surrounding highly susceptible trees did not appear to prevent disease or minimize disease severity. The clones most severely affected by the various pathogens are listed in table 1. These clones should not be planted where these pathogens are known to be a problem. Most of the clones severely affected by *Septoria* were declining, leaving large openings in the plantations. From a management standpoint, the best strategy may be to plant trees of several resistant clones in monoclonal blocks in a mosaic pattern. These blocks could then be treated individually if a disease outbreak necessitated chemical control or early harvest.

Pruning/Sanitation

Pruning was ineffective in reducing the incidence of Septoria canker. New branch and stem cankers were common above the pruned portions of trees. The number of trees with cankers per plot ranged from 7 to 16 before treatment in 1982 and from 10 to 18 after treatment in 1986. Most stem cankers either killed trees or killed the tops, predisposing affected trees to wind breakage. Overwintering inoculum in the leaf litter (Ostry 1987) evidently was disseminated into the upper crowns of the pruned trees. Previous work also has shown that sanitation is not an effective control strategy for *Septoria* if abundant inoculum is present within adjacent trees (Ostry 1987). Spore trap counts

Figure 2.–*Multiple stem cankers caused by* Septoria musiva *on a highly susceptible* Populus *clone.*

revealed similar numbers of conidia of *Septoria* and ascospores of *Mycosphaerella* in all plots throughout the growing season.

Tree mortality was 4 percent within all the study plots. Thirteen percent of the remaining trees had Septoria cankers; 8 percent of the affected trees had dead or broken tops. Differences in clonal susceptibility were evident; most cankers were associated with only a few clones. There was no increase in the incidence of poplar-willow-borer attacks from 1982 to 1986, and there seemed to be no clonal preferences.

SUMMARY

Septoria musiva caused extensive damage to highly susceptible hybrid poplars in many production plantings in central lower Michigan. Stem breakage was common within 5 years after plantation establishment. Severity differed by clone, not

site. Pruning the lower branches to reduce infection sites and removing *Septoria*-infected trees failed to reduce disease incidence and severity within plantations. Planting resistant and susceptible clones in random mixtures did not protect the susceptible trees from infection. Inoculum produced on leaves of susceptible trees was dispersed throughout plantations, causing an unacceptable incidence of disease. Planting blocks of resistant clones in a mosaic pattern will allow blocks of severely affected clones to be harvested early, if necessary, while the remainder of the plantation is managed as originally planned. Planting only resistant clones in monoclonal blocks is recommended to minimize the serious risk of this pathogen.

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Describes the impact of Septoria canker on hybrid poplars in production plantations and the results of cultural control studies.

KEY WORDS: *Populus*, canker, intensive culture.

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